OPINION PIECE

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Science Communication: A Basic Skill That Needs To Be Developed In Undergraduate and Graduate Programs

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ABSTRACT

Communication skills are one of the most widely recognized learning outcomes for numerous programs in higher education. However, proper training in science communication (SciComm) skills are consistently falling short of requirements. This highlights the need to examine the curriculum as a whole as opposed to a course level view. In this piece, I present arguments expressing the need for proper incorporation of formal communication training in undergraduate and graduate programs to enhance the quality of discourse between scientists and the lay public. Specifically, this opinion piece briefly describes the current state of SciComm training and the lack of core skills in existing courses, the essence of science communication and teaching, and its impact in the workplace.

Keywords: Science, communication, skill, training, program, teaching

INTRODUCTION

Communication skills are a largely recognized learning outcome across undergraduate science programs.[1] The responsibility of communicating a multitude of science research, breakthroughs, and discoveries to various individuals with differing levels of education has been linked to science practitioners.[1] Today, there is a global push to improve scientists' ability to communicate research to avoid the translation of misinformation, inadequacy, and poorly executed knowledge that prevents proper diffusion of science and sustainability of practises.[2,3]

Today, the COVID-19 pandemic has proven the importance of science communication in an age of misinformation as new knowledge is abundant, evolving, and controversial.[3] For example, the misinformation of science and the lack of proper public communication surrounding the pandemic can hinder population health and protocol by leading to negative outcomes.[3] The continued outbreaks, the uncertainty in receiving the vaccine, and the controversy over wearing a face mask are unfortunate examples of how disorganized science communication can confuse non-scientific audiences.[3] A lesson that has become clear during this pandemic is that not properly disseminating information towards the public makes it a challenge to counter misinformation as it leads to confusion.[3] Numerous amounts of scientific evidence are presented each day, often times contradicting one another and making opposing claims about the reality and seriousness of an issue.[4] This results in public hesitation stemming from their inability to distinguish and understand the information presented to them.[3] Upon reading the information, skepticism enters the public's perception of scientists and the entirety of the of science field, followed by distrust.[4] This leads to distrust of scientific evidence and casts doubt about the justification for health protocols and alterations in personal behaviour as new information surfaces.[3]

The ineffective communication the public receives is not due to a lack of science literacy, but failure for scientists to acquire formal training in science communication during their undergraduate and graduate science programs, which acts as a barrier.[5] Currently, scientists are encouraged to learn and are trained in analytical skills, research methodologies, problem-solving, critical thinking, and scientific writing between other scientists. These skills are at the basis of being an effective scientist in order to conduct exceptional research. However, the same scientists do not learn the fundamentals required to communicate their research to a layperson audience, as their oral, interpersonal, and written communication skills are not challenged in their program.[2] In order to meet this requirement, increasing the inclusion of communication training as a mandatory or a 'generic' learning outcome of science programs will ensure graduates possess relevant skills required to live productive professional lives in various careers.[2] The current state of scientific training seems to lack the inclusion of conveying information effectively among various audiences outside the academic

discipline.[6] This presents a call for examination into current science programs to assess and map the effectiveness of science communication training at both an undergraduate and graduate level.

DISCUSSION

What is Science Communication?

The field of Science Communication (SciComm) is continuously evolving and a developing discipline of research and practise.[7] Science communication entails using a variety of skills to translate scientific philosophies, knowledge, research, and critiques, to a non-science audience in an accessible, engaging, and useful manner. To make a piece of work accessible, means an audience with varying communication needs can understand the information presented to them. The purpose of SciComm is to introduce narratives to non-scientists. Furthermore, science communication is an interdisciplinary field that includes a broad range of areas, incorporating science, communication, education, pedagogy, psychology, philosophy, and sociology of learning.[5] Effective practise of SciComm skills will produce a response in individuals, such as Awareness, Enjoyment, Interest, Forming an Opinion, and Understanding (AEIOU).[7] It is important to understand that this area of academia is not meant to encourage scientists to discuss more about their work, but to make sense of their science and explain it in a digestible fashion to inform and inspire the intended audience.[5] Given the interdisciplinary nature of the field and varying definitions and opinions, the purpose of this piece is to explain to readers what science communication entails.[5]

Science communication training: the current state and the lack of core skills

The skill 'Communication' has been introduced as a learning outcome for science degrees in many countries, including Canada.[5] Recognizing that the communication of science needs to be better taught, has resulted in an increased number of courses designed to teach and train students about effective communication techniques.[5] Although this acknowledgment is a positive step in better educating early scientists, their efforts to learn are hindered as there is little evidence to support what content should comprise the core element(s) taught in science communication courses and/or the depth with which each element should be taught.[5] The 12 core science communication skills are: identifying and understanding a suitable target audience, using appropriate language for the target audience, identifying the purpose of the intended communication, proper consideration of target audiences' prior knowledge, identifying vital information from non-important content, choosing the best platform to communicate with the targeted audience, properly considering the social/political/cultural content of scientific information being presented, identifying appropriate modes of communication (i.e. humour, analogies, diagrams), understanding the underlying theories leading to science communication, ensuring audience engagement, storytelling and narrative techniques, and two-way dialogue between the presenter and the audience.[5]

The absence of undergraduate and graduate students' possession of "generic" communication skills is the result of the limited opportunities in the science curriculum due to the lack of courses offered, the access to such course(s), the encouragement for students to enrol in SciComm directed courses, and how important a student perceives SciComm.[1,2,5,6] Elective science communication courses tend to attract scientists who actively seek communication opportunities to learn or pique their interest in specific careers in SciComm.[5] The inclusion of science communication content in other science courses (non-SciComm based) is dictated and at the discretion of the scientists in charge of lecturing.[5] This is a challenge as these professors often times take part in and practise traditional science communication between individuals in the same field, which involves scientific jargon and language.[5] Although professors are experts in discipline-specific content, they may be unaware what pedagogy is the most effective to learn material. In general, professors encounter challenges in communicating science effectively to a range of audiences, due to their in ability to limit the use of the academic discipline-specific content they pose when explaining science.[5] As scientists progress through undergraduate studies to post-graduate and then doctorate, they inevitably become more specialized in their field of study. This poses a challenge to also become a master in science communication. This calls into question a scientist's/professor's level and ability to demonstrate a desired skill like 'communication', as they may also find it challenging to perform communication practises. Since educators play an integral part in training and preparation of students in their specialized field of study, the lack of professors possessing a background or knowledge in SciComm suggests a deficiency of prospective students obtaining these skills, too.

One key research paper has presented results giving reason to assess the effectiveness of current SciComm training across respected universities. Researchers Mercer-Mapstone and Kuchel examined which science communication skills were being taught and assessed directly, indirectly, or were altogether absent in undergraduate science courses across four research intensive universities.[1] The researchers found that 10 of the 12 core science communication skills were absent in more than 50% of assignments, with a little over 20% of assignments containing more than five skills.[1] Specifically, the 2 core communication skills that were

directly taught were audience engagement and modes of communication.[1] Furthermore, 77% of all assessments administered by professors in these courses taught less than five core communication skills and 22% taught five or more directly.[1] An important result to mention is the significant difference in how openly the communication skills were taught across different science majors/disciplines.[1] This is a critical finding, as based on the field of science that one is in, there is a lack of explicitness and diversity in the way communication skills are being taught.[1] An encouraging trend identified was that communication assignments geared towards non-scientific audiences were taught more directly than assessments targeted at scientific audiences.[1] However, the failure to develop the necessary core science communication skills challenges the ability of early scientists to communicate to a non-scientific audience. One such example is the ability to determine whether a word is considered jargon.

This study provides motivation to encourage similar studies across all universities worldwide that are known for their respected science programs to understand the current state of science communication training and their efforts/motivate to ensure its necessary incorporation into the curriculum.

Communicating to the public, the essence of SciComm: a challenge

The significance of writing for a lay person audience is essential, as there is a need to increase health and science literacy in a variety of topics.[8] Therefore, it is important to understand the definition of 'public' with regards to science communication. The 'lay public' is everyone in society; hence it is a heterogenous group encompassing a mixture of individuals of varying age, professions, cultures, socio-economic circumstances and levels of knowledge.[7,8] Furthermore, the 'lay public' also includes other scientists who are non-experts in the field of science that is being presented to them.[7]

It is no secret that science journalism is the gateway for spreading scientific material and news to the public. Science journalists that obtained the skills necessary for transmitting science information are able to make complex topics accessible to a lay audience, while ensuring accuracy. However, informing the public on matters related to science has become increasingly difficult for graduates of science degrees due to lack of proper teaching of science communication, explicitness, and diversity in the way communication skills are being taught to students, such as communicating to non-scientists.[1,9] The reason for the detachment between the science community and the public is that SciComm is not typically a part of formal training for scientists at any academic level.[9] In the United States, only 3 of the 10 top neuroscience PhD programs have elective courses or seminars; however, none have required courses.[9] Since material can become oversimplified and generalized, this can lead to basic information being obscured.[8] This spread of misinformation and communicating research effectively presents as a challenge in science journalism.[8] Scientists are trained to publish papers and discuss findings with their peers, hence making it challenging for them to understand how lay audiences think and interpret.[8] Communicating scientific findings and analysis of results becomes difficult, due to discipline-specific jargon and language.[8] This problem often arises as scientists fear being misunderstood and presenting inaccurate information, resulting in using extensive specialized language.[8] Lay audiences oftentimes find jargon challenging to comprehend, confusing, and overwhelming.[8] A lack of SciComm training makes it difficult for practising scientists to determine whether a word is jargon or a typical term making communication of scientific concepts to the public a challenge.[8] A simple word, such as 'significant', can be considered as jargon, as not every individual accurately understands its meaning. Furthermore, phrases such as 'positive correlation' may be inferred as something confident; however, it can actually represent a negative link between two things. Although practising scientists may not acknowledge the importance of writing to a lay audience, the ability to write for a wide range of individuals becomes increasingly important with regards to continuing their research. For example, in order to obtain funding for research, scientists must be able to clearly communicate to peers, reviewers, and other public bodies about how their ideas and discoveries are valuable and applicable to society. Scientists are an essential link between policy makers, taxpayers, stakeholders, and governments. The ensure evidence-based decision making occurs through these individuals based on their research explanation and its implications.[6,10]

Therefore, the gaps between what scientists believe the public knows and what the general public truly understands can be bridged by incorporating formal communication skills when training scientists during their undergraduate and graduate programs. This will provide the quality of discourse needed between scientists and the general public.

Science Communication Training and the Workplace

Today, the science community has been identified as the least trained group of professionals with regards to public communication.[11] Communication is one skill that is consistently highlighted by a variety of professionals, including educators, employers, and government officials, as it is a requirement for science graduates to possess.[5] However, employers in the United Kingdom, United States, and Canada found that the

training received by graduate students does not reflect the reality of the modern day workplace requirements needed to be successful.[1] Specifically, successful graduates of science program are well-rounded, meaning they are able to successfully demonstrate analytical, technical, problem-solving, and communication skills.[5] However, their communication skills are consistently falling short as they fail to meet the needs of write in contexts beyond academic.[5] Therefore, they also fail to meet the needs of what is required of a science career in real world settings.[5]

Every year, a set of learning outcomes are established that act as a threshold for acquiring knowledge that can help to guide curriculum development.[2] This, in turn, promotes graduate employability.[2] Learning outcomes describe the knowledge, skill, and fundamentals one should acquire upon completion of an evaluation, course, or program.[12] Within an undergraduate or graduate program, the learning outcomes stated that one should acquire upon completion of their degree is comprised of the learning outcomes stated within the classes offered throughout the program.[12] Although professors have the freedom to design courses, the ministry of education has introduced 'communication' as a learning outcome for science degrees, which should aid in curriculum development.[5] Specifically, in higher education, professors/scientists/lecturers within science programs are responsible for the development of course design.[5] Therefore, they are also responsible for forming and designing the learning outcomes.[5] However, since these individuals are typically experts in one primary field of study, they select priorities, skills, and applicable knowledge based on the course's topic from a large set of learning goals.[13] As a result, they often omitting or failing to make science communication a key outcome.[13] Today, science professionals hardly have the time, resources, or formal training to communicate their own research to non-scientific audiences, let alone helping students find resources, developing assessments that help students build the necessary skills; or developing the components of courses(s) needed to accurately reach communication.[5] This results in failed SciComm education and a lack of training.[5]

Therefore, the reservations expressed by workplace professionals calls to question the science communication training in both undergraduate and graduate programs. There are various complaints from journalists, industries, government officials, and the public stating that scientists are not equipped with the proper communication skills needed to convey information effectively to non-experts.[1] This demonstrates that there is a discrepancy between what universities say science graduates should be able to do and the quality of skills they actually possess upon completion, including the need for improved training and courses.[1] Therefore, it is imperative to improve communication training in higher education to create a solid foundation for graduates of a science program and employability.

Integrating SciComm training into the current curriculum

In an effort to provide suggestions to address this serious issue in training scientists, I strongly believe each science course, regardless of the discipline (i.e. chemistry, biology, physics), should include an assignment dedicated to writing towards a lay audience. Although integrating these resolutions into the curriculum would be complex, requiring money and time, this is nonetheless valuable in helping solidify a student's acquisition of science communication skills. When one is in their desired program of choice, they tend to place energy/take more seriously the courses directed towards that discipline. However, in general, elective courses tend to not receive the same level of effort as program specific courses; hence, this results in a lack of assertiveness to learn its content. Often times, science communication courses are offered as elective classes, which does not motivate students to enroll in them as they tend to place moderate or limited importance on SciComm skills.[14,15] Therefore, I strongly believe during each academic year, it should be mandatory to have science students take one course directed at learning science communication skills, ensuring that they are developing these fundamentals throughout their program and building on existing competences in this field of practise. This means within science programs, SciComm courses should not be elective, rather, required as a significant portion of literature on this topic has stated that students in undergraduate and graduate BSc. programs fail to acquire these skills as discussed in this opinion piece.

CONCLUSION

This opinion piece brings forth the importance of science communication training in undergraduate and graduate science programs by briefly describing the current state of SciComm training and the lack of core skills, the essence of science communication and teaching, and its impact in the workplace. There is a growing body of research on the 'science' of science communication and how it impacts practising scientists throughout their career, including the benefits they gain from their ability to communicate their work to a range of audiences.[10]

Today, there remains numerous gaps in the current state of science communication training and little consensus on how SciComm training should be conveyed. Undergraduate and graduate students are receiving no explicit formal training in the communication of science theories. In this area of academia and pedagogy,

there is a lack of research which examines the communication of science skills at a whole degree level. Furthermore, a significant portion of the research on science communication skills focuses on teaching practises only at a microlevel, such as an individual course or a single assignment. Therefore, these gaps prove there is insufficient formal training in communication of scientific concepts and practises to the lay audience. In addition, evidence surrounding how current students are experiencing the teaching and learning of these skills remains scarce. A current thesis project at McMaster focuses around understanding the effectiveness and impact of current SciComm training, as well as understanding how university students feel about the importance of science communication.

Change is needed in current teaching practises and course design in BSc programs to equip graduates with the proficiency in a diverse range of communication skills. Building these skills are a challenging undertaking, involving the restriction of discipline-specific jargon and effective engagement with the target audience (lay public) to determine their level of knowledge. Higher education needs to be focused on developing these skills in courses that incorporate a balance of knowledge through scientific content, research training, and the ability to effectively communicate to form well-rounded aspiring scientists who are ready to practise in the workforce.

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